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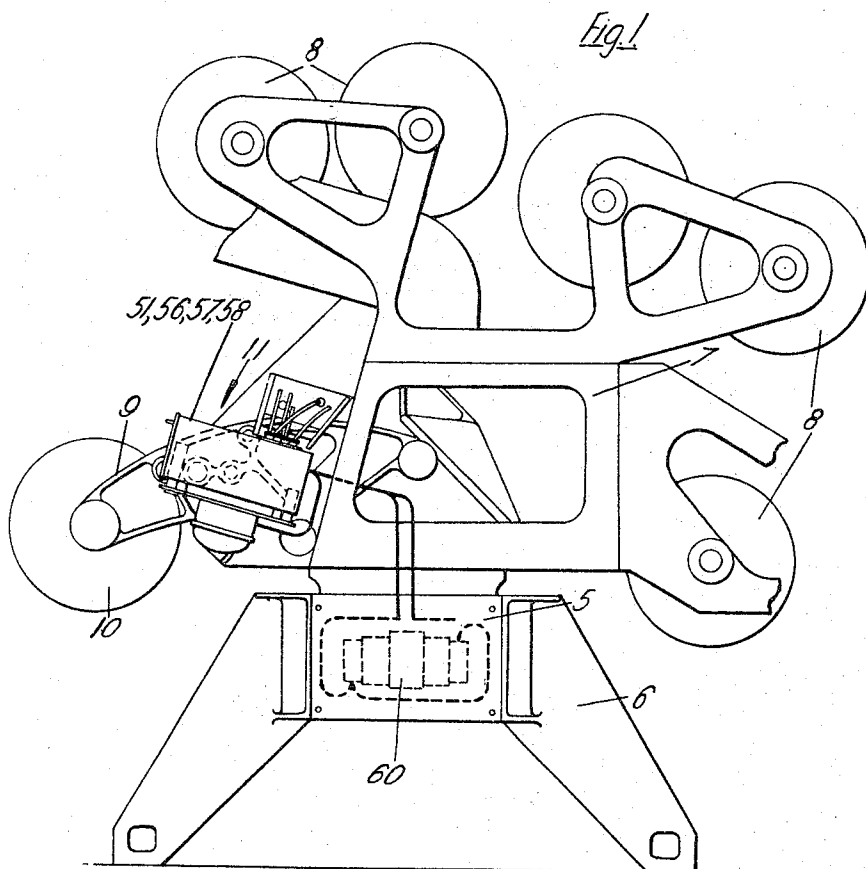
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CONTROLLED HEATING OF FLAT WARP KNITTING MACHINES

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4 Sheets-Sheet 1



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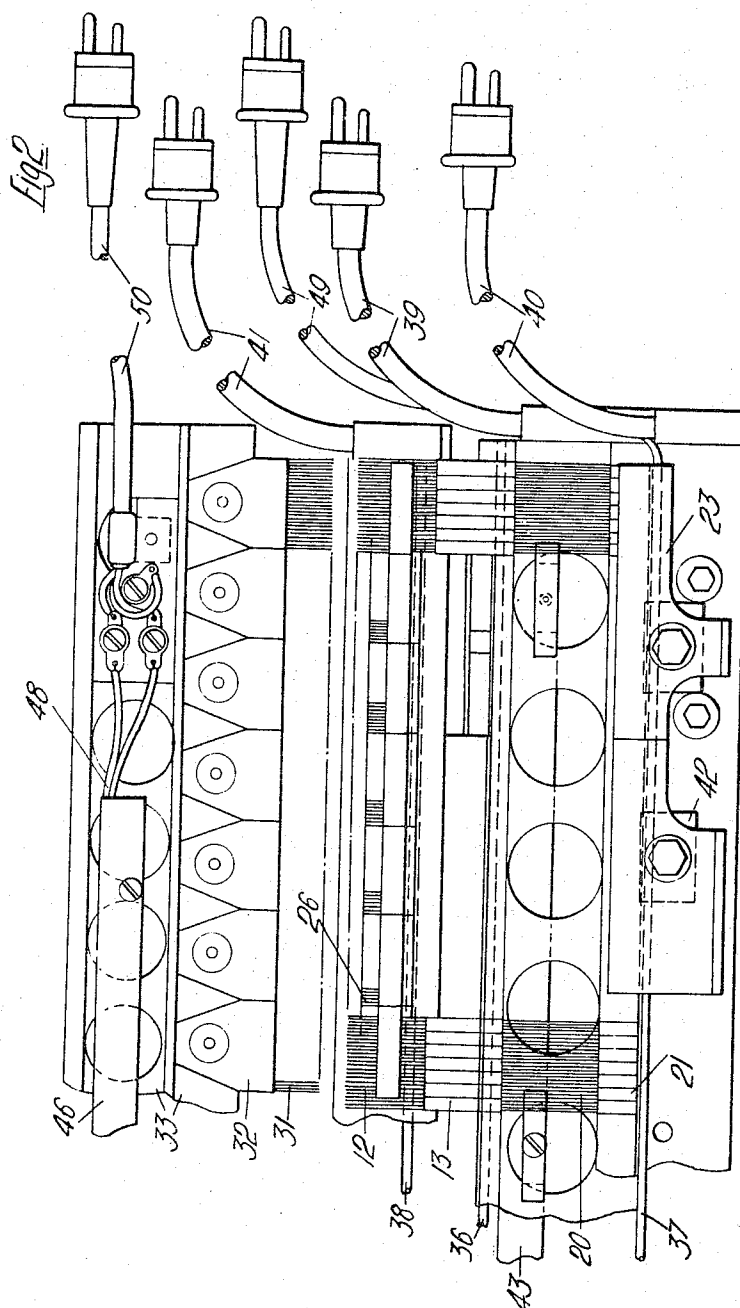
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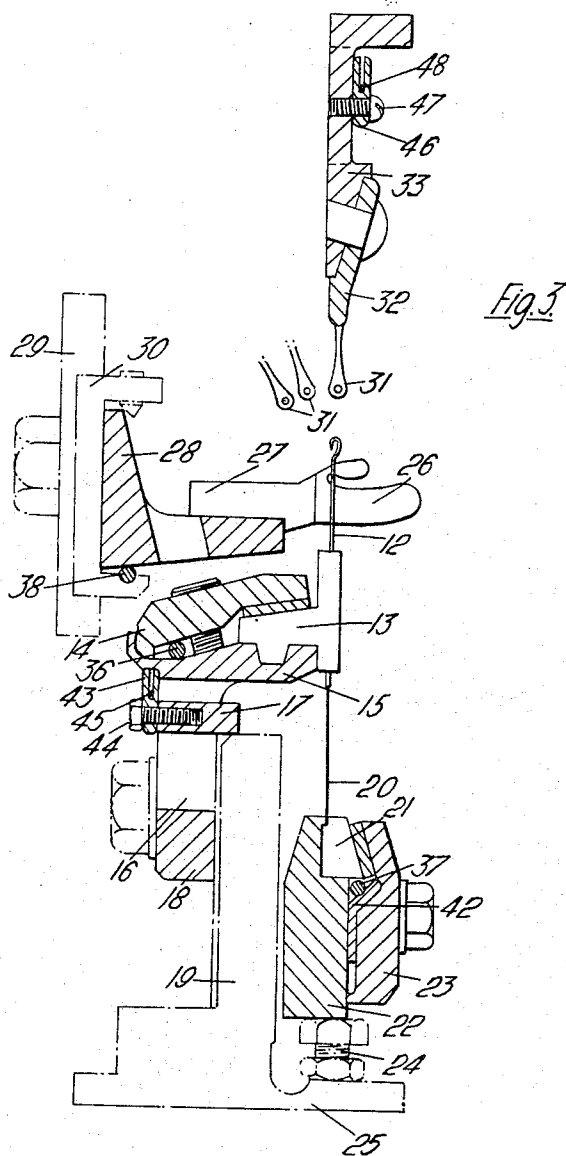
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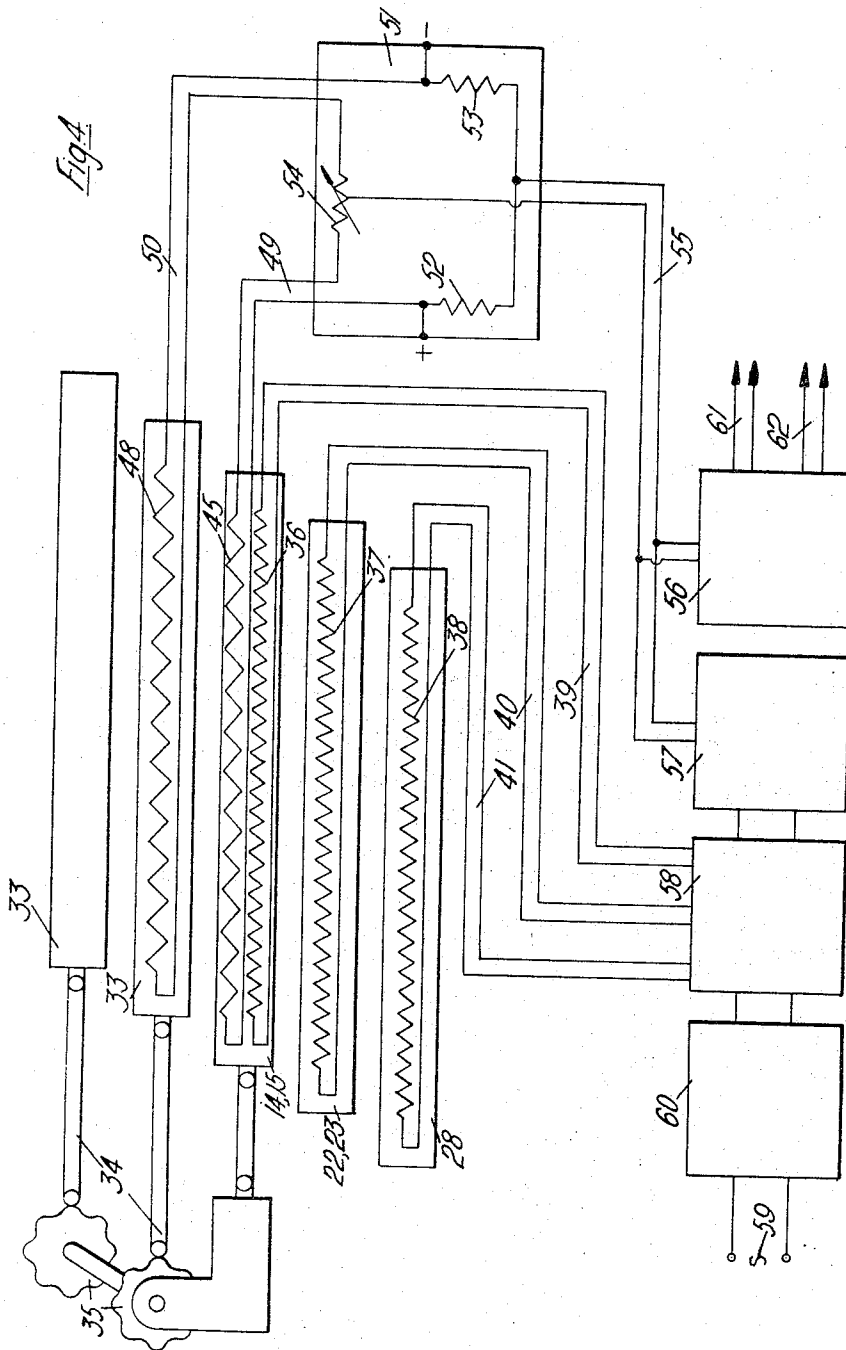
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3,347,063

CONTROLLED HEATING OF FLAT WARP KNITTING MACHINES

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3 Claims. (Cl. 66—86)

ABSTRACT OF THE DISCLOSURE

A flat warp knitting machine comprising means including a Wheatstone bridge circuit for obtaining a constant predetermined temperature differential between a guide bar thereof and either the needle bar, sinker bar or tongue bar.

In flat warp knitting machines of fine gauge there are very small clearances between the needles and other knitting elements which mesh together and move between each other as they make their knitting movements. For example, the nominal pitch of the knitting elements in one particular machine is 0.0357 inch. Within this pitch are a needle with a hook stem thickness of 0.012 inch and a thread guide having a thickness of 0.007 inch. This leaves a total clearance of 0.0167 inch divided equally on each side of the needle into clearances of 0.00835 inch. The friction of the threads rubbing on the needles is greater than the friction of the threads on the guides and also the needles lie closer to the other knitting elements than the guides. The result is that a temperature differential of 10° C. may be built up while the machine is running between the needle bar and the guide bar.

This temperature differential of course gives rise to a differential expansion of the needle bar and guide bar and if these bars are made of an aluminum alloy so that their mass is kept low, the temperature differential will give rise to a difference in expansion over the whole length of the machine of a nominal width of 168 inches of 0.369 inch. If the needle and guide bars are made from a steel alloy to provide a good fatigue strength, this differential expansion is reduced in the ratio of the coefficients of expansion between aluminium and steel and the total difference is 0.0185 inch. It will readily be appreciated however, that very careful account must be taken of these expansions in the assembly of the machine.

Generally the guides themselves and the needles are die-cast into metal blocks in short lengths and these blocks are individually fitted to the needle and guide bars. To ensure that the proper clearances are maintained when the machine is running, it is necessary to provide stable temperature conditions of the needle bar and guide bar during the whole period that the guides and needles are fixed to them and this is usually not less than eight hours. Even then, the conditions which have been maintained will not generally be maintained during the running of the machine and therefore the clearances at one end of the machine or the other will alter as the temperature differential changes.

There is not the same problem in the assembly of the sinkers and also the tongues in the kind of machine in which these are provided for closing the needle hooks, because it is found that the temperature differential which occurs between the sinker bars, the tongue bars and

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the needle bars is very much less than the differential between all these bars and the guide bar or bars because the needle bar, sinker bar and tongue bar are all in close proximity to each other and in close proximity to the bed of the machine.

With the aim of overcoming the difficulties which are inherent in the differential expansion between the guide bar or guide bars and the bars of the other knitting elements, according to this invention, we fit the needle bar, sinker bar and, where one is provided, the tongue bar all with electrical heating elements, and we fit one guide bar and one of the needle, sinker and tongue bars with electrical resistance thermometer wires which are connected in two arms of a Wheatstone bridge circuit that controls the supply of current to the heating elements. The bridge is balanced when a predetermined temperature differential exists between the two bars to which the electrical resistance thermometer wires are fitted and the circuit then switches off the heating elements, but the bridge is unbalanced when there is a reduction in the temperature differential, and the current which then flows through the bridge causes the heating elements to be switched on until the predetermined differential is restored.

With this arrangement the predetermined difference in the temperature of the needle, sinker, and possibly tongue bars above that of the guide bars, which is preferably slightly above the natural differential which is usually found to exist in use of about 10° C., can be maintained both when the machine is running and when it is at rest.

The present invention also includes a method of assembling a flat warp knitting machine wherein the knitting element bars of the machine are fitted with electrical heating elements and electrical resistance thermometer wires respectively under the control of and connected to a Wheatstone bridge control as described above, and the knitting elements are fitted to their bars while the predetermined temperature differential is maintained.

The predetermined temperature differential is therefore maintained during the whole time that the knitting elements are being fitted in position and they can therefore be carefully adjusted to maintain the required clearances between the elements. When the machine is assembled and running exactly the same temperature differential is still maintained and therefore all the running clearances are accurately maintained also.

We have found that the best results are obtained by fitting the temperature sensing wires to one of the guide bars when there are a number provided and to the needle bar. The heating elements of the sinker bar and also the tongue bar, when there is one, are then switched on and off in dependence upon the temperature differential which exists between the needle bar and the guide bar, because as already stated, the temperature differential between the needle, sinker and tongue bars is small and by providing heating elements of the correct capacity these bars are all heated up together by the same amounts.

One example of a flat warp knitting machine constructed in accordance with the present invention is illustrated in the accompanying drawings in which:

FIGURE 1 is an end elevation of the machine;

FIGURE 2 is a front elevation of part of the knitting elements of the machine;

FIGURE 3 is a section through the knitting elements showing the essential components at one point along the machine; and,

FIGURE 4 is a diagrammatic electrical diagram illustrating the provision of the electrical heating elements and electrical resistance thermometer wires.

The machine has a bed 5 standing on legs 6, and comprises frames 7 at each end. A number of warp beams 8, five of which are shown in FIGURE 1 of the drawings, are supported between these frames. Cantilever support arms 9 at each end of the bed 5 support a fabric take up roller 10 between them and the knitting elements at the knitting point 11 extend along the length of the machine and are mounted on the bed 5.

As shown in FIGURES 2 and 3, the knitting elements comprise a row of hollow needles 12 which are diecast in sections in metal blocks 13, a number of which are mounted end to end clamped between two parts 14 and 15 of a needle bar which extends along the full length of the machine. The lower part 15 of the needle bar is formed integrally with a number of downwardly extending legs 16 interconnected by longitudinal webs 17 and 18 which rest against an upstanding portion 19 of the bed. A row of needle tongues 20 which slide within the hollow needles 12 are diecast in sections in metal blocks 21 a number of which are clamped end to end between parts 22 and 23 of a tongue bar which also extends along the full length of the machine. The tongue bar moves up and down relatively to the needle bar so that the tongues 20 open and close the needles 12 and the lowermost position of the tongue bar relatively to the needle bar is determined by an adjustable abutment 24 supported on an arm 25 of the member 19. A number of sinkers 26 extend one between each adjacent pair of needles 12 and are formed in sections integrally with metal blocks 27. The blocks 27 are mounted end to end on a sinker bar 28 which extends along the full length of the machine and is supported at intervals from a member 29 by a number of G-brackets 30. A number of rows of warp guides 31, of which three are shown in FIGURE 3, are mounted above the needles 12, one warp guide from each row corresponding to each needle. Each row of guides 31 is divided into sections which are diecast in metal blocks 32 and the metal blocks 32 are mounted end to end on a guide bar 33 extending the length of the machine. In operation the needles 12 and the needle tongues 20 move up and down, the sinkers 26 move transversely to the needles and the guides 31 move transversely between the needles and also carry out longitudinal shogging motions, in a sequence determined by the pattern to be knitted. As suggested in FIGURE 4, the guide bars 33, of which only two are shown in FIGURE 4, are moved longitudinally by struts 34 which follow pattern drums 35.

Electrical heating filaments wires 36, 37 and 38 are fitted to and extend the full length along the needle bar, tongue bar and sinker bar, respectively, and are supplied with current through terminal leads 39, 40 and 41, respectively. The filament 36 is clamped between the parts 14 and 15 of the needle bar. The filament 37 is clamped between the parts 22 and 23 of the tongue bar and rests against a series of felt washers 42. The filament 38 rests in grooves in the bottoms of the G-clamps 30 and is held against the underside of the sinker bar 28.

A strip 43 of U section is fixed by screws 44 at intervals to the back of the web 17 of the part 15 of the needle bar and an electrical resistance thermometer wire 45 rests in the groove in the strip 43. A similar strip 46 is secured at intervals by screws 47 to the front of one of the guide bars 33 and a second electrical resistance thermometer wire 48 rests within the groove of the strip 46. The resistance wires 45 and 48 are connected through terminal leads 49 and 50, respectively, to a control device through which current is supplied to the heating filaments 36, 37 and 38.

The electrical circuitry is shown diagrammatically in FIGURE 4. The two resistance thermometer wires 45 and 48 each have a resistance of approximately 60 ohms and are connected in two arms of a Wheatstone bridge circuit

51 which is mounted at one end of the machine and across which there is provided a 10 volt DC potential. Fixed resistances 52 and 53 of approximately 100 ohms each make up the other two arms of the bridge and a variable resistance 54 for calibration purposes is provided at the junction of the resistance wires 45 and 48. The current flowing in the bridge is tapped by a pair of wires 55 leading to a safety differential amplifier 56 and a control differential amplifier 57, both also mounted at the end of the machine. The control differential amplifier amplifies the out of balance current from the bridge 51 as necessary and passes it on to a heater switch 58 which is also mounted at the end of the machine and which includes relays controlling the supply of current from an AC supply 59 through a transformer 60 along the terminal leads 39, 40 and 41 to the heating filaments 36, 37 and 38, respectively, each of which dissipates approximately 400 watts.

In operation the temperature of the needle bar, tongue bar and sinker bar, which are sufficiently close to one another and to the bed 5 of the machine for their temperatures to be assumed to be approximately the same, is sensed by the resistance thermometer wire 45 and the temperature of one of the guide bars 33, which is assumed to be substantially the same as that of all the other guide bars 33, is sensed by the resistance thermometer wire 48. These two temperatures are compared in the Wheatstone bridge 51 and the variable resistance 54 is adjusted until the bridge is balanced when the temperature of the wire 45 is for example, 12° C. higher than that of the wire 48. Under these circumstances no current flows through the leads 55 and consequently the heater switch 58 ensures that no current flows through the leads 39, 40 and 41 so that the elements 36, 37 and 38 are not heated. If the temperature differential as sensed by the wires 45 and 48 falls below the set value, a current flows in the bridge circuit 51 and causes relays in the heater switch 58 to operate so that power is supplied to the filaments 36, 37 and 38 until the predetermined differential temperature is reached again.

In the absence of the heating filaments 36, 37 and 38, the temperatures of the needles 12, needle tongues 20 and sinkers 26, which can be considered to be substantially the same, would under normal operating conditions exceed that of the guide eyes 31 by up to 10° C. However, this differential would not be constant and any variation in the temperature differential would cause differential expansion of the rows of knitting elements so that the clearances between the elements would be incorrect. By positively heating the needles, tongues and sinkers so that their temperature is greater than that of the guide eyes 31 by an amount which exceeds that which would naturally occur in practice, a constant differential temperature, except in the most exceptional conditions, can be maintained. If the predetermined temperature differential is maintained while the blocks of needles, tongues, sinkers, and guide eyes are fitted to their respective bars during assembly of the machine, they can be mounted with the correct clearances which will exist during normal operation.

Since the guide bars 33 are not heated, the temperature control circuit can only compensate for reductions in the predetermined temperature differential, that is the variation which is most likely to occur in practice.

We claim:

1. A flat warp knitting machine comprising a first set of bars including a needle bar and a sinker bar, electrical heating elements mounted to heat each bar of said first set, a set of guide bars, electrical resistance thermometer wires connected to one guide bar and one of said first set of bars, a Wheatstone bridge circuit, said circuit comprising two arms and one of said resistance wires being connected into each arm, said bridge being adjusted to be balanced when a temperature differential of a predetermined value exists between the two bars to which the elec-

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trical resistance thermometer wires are connected, and electrically actuated means for connecting said heating elements to a source of electric power, said electrically actuated means being connected to said Wheatstone bridge to be actuated by current received through said bridge whenever a change in said temperature differential from said predetermined value unbalances said bridge and causes a current to flow therethrough.

2. A machine according to claim 1, wherein the electrical resistance thermometer wire connected to said first set of bars is fitted to the needle bar.

3. A flat warp knitting machine as claimed in claim 1 wherein said first set of bars includes a tongue bar.

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